
Division 3

SECTION 03000**CONCRETE AND CEMENT FINISH****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. The general provisions of the contract, including general and special conditions and general requirements (if any), apply to the Work specified in this section.

1.02 DESCRIPTION OF WORK

- A. Furnish and install all materials, labor and equipment necessary to properly perform all concrete work required for a complete project. Include all concrete, metal reinforcing and finishes.
 - 1. Related Items of Work: Particular attention is directed to required items of work which are related to and usually associated with the work of this section of the Outline Specifications, but which are to be provided as part of the work of other sections.
 - 2. Codes and Standards: Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified:
 - a. ACI 301 "Specifications for Structural Concrete for Buildings."
 - b. ACI 311 "Recommended Practice for Concrete Inspection."
 - c. ACI 318 "Building Code Requirements for Reinforced Concrete."
 - d. ACI 347 "Recommended Practice for Concrete Formwork."
 - e. ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete."
 - f. Concrete Reinforcing Steel Institute, "Manual of Standard Practice."
 - g. Montana Public Works Standard Specifications, Fifth Edition, March 2003
- B. The work described in this section applies to poured-in-place concrete assemblies and installations. At the Design-Builder's option, precast concrete jail cell modules and assemblies may be used for secure housing areas. Manufacturers providing precast concrete jail modules meeting the required quality include the following:
 - 1. Tindall Corporation, Spartanburg, SC
 - 2. Oldcastle Precast Modular Group, Telford, PA
 - 3. Rotondo Weirich Enterprises, Lederach, PA
 - 4. Other manufacturers providing equivalent products may be approved by Owner's Project Manager.

1.03 WORKMANSHIP

- A. The Design-Builder is responsible for concrete work that does not conform to the specified requirements, including strength, tolerances and finishes. Correct deficient concrete as directed by the Owner's Project Manager.

1.04 SUBMITTALS

- A. Shop Drawings - Concrete Reinforcement: Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with the ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup

spacing, diagrams of bent bars, arrangements of concrete reinforcement. Include special reinforcement required and openings through concrete structures.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Forms for Exposed Finish Concrete:
 - 1. Construct all formwork for exposed concrete surfaces with plywood, or other acceptable and approved panel-type materials, to provide continuous, straight, smooth, exposed surfaces.
 - 2. Furnish in largest practicable sizes to minimize number of joints.
 - 3. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection.
- B. Forms for Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material.
- C. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compound.

2.02 REINFORCING MATERIALS

- A. Reinforcing Steel Bars: ASTM A 615, Grade 60 (AASHTO M 31) or ASTM A 705, Grade 40 or Grade 60.
- B. Steel Wire:
 - 1. ASTM A-82 Plain, cold-drawn steel.
 - 2. AASHTO M 32 Cold Drawn Steel Wire for Concrete Reinforcement
- C. Welded Wire Fabric:
 - 1. ASTM A-185 Welded Steel Wire Fabric.
 - 2. AASHTO M 55 Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
- D. Bar Mats: AASHTO M54 (ASTM A 184).
- E. Supports for Reinforcement:
 - 1. Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening bars and welded wire fabric in place. Use wire bar type supports complying with CR31 recommendations.
 - 2. For slabs on grade, use supports with sand plates, horizontal runners, or concrete brick as approved by Owner's Project Manager where wetted base materials will not support chair legs.
 - 3. For exposed to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are hot-dip galvanized, or plastic protected, or stainless steel protected.

2.03 CONCRETE MATERIALS

- A. Ready-Mixed Concrete: ASTM C 94
- B. Portland Cement: ASTM C 150

- C. Fly Ash: ASTM C 618, Type F
- D. Aggregates:
 - 1. Fine and coarse aggregate: Conform to ASTM Designation C-33.
 - 2. Water: Clean, fresh, drinkable.
 - 3. Air-Entraining Admixture: ASTM C-260.
 - 4. Water-Reducing Admixture: ASTM C-494, Type A.
 - 5. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C-494, Type F or Type G.
 - 6. Set-Control Admixtures: ASTM C-494, as follows:
 - a. Type B, Retarding.
 - b. Type C, Accelerating.
 - c. Type 0, Water-reducing and Retarding.
 - d. Type E, Water-reducing and Accelerating.
 - e. Calcium chloride will not be permitted in concrete.

2.04 GROUT FOR STEEL BEARING PLATES

- A. See Section 05120.

2.05 RELATED MATERIALS

- A. Preformed Expansion Joint Fillers: Provide closed-cell synthetic rubber joint filler.
- B. Joint Sealing Compound: Provide polyurethane-sealant (see Section 07900.)
- C. Vapor Retarder: Provide vapor retarder cover over prepared granular base material below all slabs-on-grade. Use only materials which are resistant to decay when tested in accordance with ASTM E 154.
- D. Granular Base: Evenly graded mixture of crushed stone to provide, when compacted, a smooth and even surface below all slabs on grade. After the vapor retarder is placed provide a compacted 2" thick evenly graded mixture of granular sand aggregates.
- E. Moisture-Retaining Cover: One of the following, complying with ASTM C-1 71:
 - 1. Waterproof paper.
 - 2. Polyethylene film.
 - 3. Polyethylene-coated burlap.
- F. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gauge galvanized sheet steel.
- G. Chemical Hardener: Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 lbs. of fluosilicates per gal.
 - 1. Products: Subject to compliance with requirements, provide one of the following or approved equivalent:
 - a. "Surfhard"; Euclid Chemical Co.
 - b. "Lapidolith"; Sonneborn-Rexnord.
 - c. "Saniseal"; Master Builders.
- H. Liquid Membrane-Forming Curing Compound: Liquid type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.555 gr./sq. cm. when applied at 200 sq. ft./gal.
- I. Bonding Compound: Polyvinyl acetate or acrylic base.

2.06 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type of concrete. Use an independent testing facility acceptable to the Owner's Project Manager for preparing and reporting proposed mix designs. Submit reports for review at least 15 days prior to start of work. Limit use of fly ash to not exceed 25 percent of cement content by weight.
 - 1. Regular Weight (150 PCF): Based upon 28 days psi compressive strength requirements, provide concrete having compressive strength of 3000 psi for all foundations and slabs-on-grade.
 - 2. Regular Weight (150 PCF): Based upon 28 days psi compressive strength requirements, provide concrete having compressive strength of 4000 psi for all structural concrete, concrete retaining walls, concrete columns, pilasters, and concrete walls. Use super plasticizer and/or other admixtures to obtain W/C ratio and slump.
- B. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Design-Builder when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Owner's Project Manager. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Owner's Project Manager before using in work.

2.07 COMPRESSIVE PROPORTIONS AND CONSISTENCY

- A. Intent of specifications is to secure, for every part of work, structural concrete of homogeneous structure which, when hardened, will have required strength and resistance to weathering.
- B. All concrete shall have water-reducing type chemical admixture at place of mixing. Comply with manufacturer's recommendations for amount of chemical admixture per bag of cement as related to temperature, humidity, and wind conditions prevailing at site at time of pouring, and dependent upon type of admixture being used.
- C. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:
 - 1. Subjected to freezing and thawing; W/C 0.50.
- D. Volumetric proportioning is not allowable. Measurement of materials shall be by weight only.
- E. The use of calcium chloride in concrete is prohibited.
- F. Use air-entraining admixture in exterior exposed concrete, unless otherwise specified. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the following limits:
 - 1. Concrete structures and slabs exposed to freezing and thawing or subjected to hydraulic pressure:
 - a. 6% for maximum 3/4-inch aggregate.
 - b. 7% for maximum 1/2-inch aggregate.
- G. Use super plasticizer in concrete for all slab construction, and in all pumped concrete as required for placement and workability.

2.08 SLUMP LIMITS

- A. Proportion and design mixes to result in concrete slump at point of placement as follows (Slump may be increased when chemical admixtures are used, provided that the admixture-

treated concrete has the same or lower water/cement or water/cementitious material ratio and does not exhibit segregation potential or excessive bleeding):

1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
2. Reinforced foundation systems: Not less than 1 inch and not more than 4 inches.
3. Concrete containing HRWR admixture (super-plasticizer): Not more than 8 inches after addition of HRWR to site-verified 2 inches - 3 inches slump concrete.
4. Other concrete: Not less than 1 inch nor more than 4 inches.

2.09 CONCRETE MIXING - READY-MIX CONCRETE

- A. Comply with the requirements of ASTM C-94, and as herein specified.
- B. Delete the references for allowing additional water to be added to the batch for material with insufficient slump. Addition of water to the batch will not be permitted.
- C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C-94 may be required.
- D. When the air temperature is between 85 degrees F and 90 degrees F, reduce the mixing and delivery time from 1-1/2 hours to 75 minutes, and when the air temperature is above 90 degrees F, reduce the mixing and delivery time to 60 minutes.

PART 3- EXECUTION

3.01 FORMS

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure.
- B. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms complying with ACI 347. Provide for openings, offsets, keyways, recesses, moldings, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required on work.
- D. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete.
- E. Chamfer all exposed corners and edges using to produce uniform smooth lines and tight edge joints.
- F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Accurately place and securely support items built into forms.
- G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete.

3.02 CONCRETE WORK TOLERANCES

- A. Except when close coordination and fitting of various trades' work precludes allowances of tolerances, maximum total permissible deviations from established lines, grades, and dimensions shall be as stated herein. Set and maintain forms in such a manner as to insure completed work within specified tolerance limits. (See Monolithic Slab Finish for concrete slab tolerances).
 1. Variation from the plumb:
 - a. In lines and surfaces of columns, piers, and in arrises, in 10 feet: 1/4 inch.

- b. For exposed corner columns, control-joint grooves and other conspicuous lines in any bay or 20-foot maximum: 1/4 inch.
- 2. Variations from the level or from grades:
 - a. In structural concrete ceiling, beam soffits, and in arrises, in 10 feet: 1/4 inch.
 - b. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, in any bay or 20-foot maximum: 1/4 inch.
- 3. Variations of the linear building lines from established position in plan and related position of columns, walls, and partitions in any bay or 20-foot maximum: 1/4 inch.
- 4. Variations in sizes and locations of sleeves, floor openings, and wall openings: 1/4 inch.
- 5. Variations in cross-sectional dimensions of columns and beams and in thickness of walls: 1/4 inch.
- 6. Variations in footings or caps:
 - a. Variation in dimensions in plan: Minus 1/2 inch; Plus 2 inches (applies to concrete only - not to reinforcing bars or dowels).
 - b. Misplacement or eccentricity: 2 percent of footing width in direction of misplacement, but not more than 2 inches (concrete only).
 - c. Reduction in thickness: Minus 5 percent of specified thickness.
- 7. Variation in steps. In a flight of stairs:
 - a. Rise: 1/8 inch.
 - b. Tread: 1/4 inch.

3.03 UNDER-SLAB FILL (GRANULAR BASE) AND VAPOR RETARDER INSTALLATION

- A. Place 4" of under-slab fill over entire area of subgrade in interior of building.
- B. For slabs-on-grade, place vapor retarder sheeting on top of granular base following leveling and tamping of granular base

3.04 PLACING REINFORCEMENT

- A. Comply with the specified codes and standards, the Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports, and as herein specified. Avoid cutting or puncturing vapor retarder during reinforcing placement and concreting operations.
- B. Clean reinforcement of loose rust and mill scale, soil, ice and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations.
- D. Place reinforcement to obtain at least the minimum coverage for concrete protection.
- E. Do not splice reinforcement at points of maximum stress. Stagger splices in adjacent bars. Lap splices in piers, struts, sufficiently to transfer full stress by bond.
- F. Protect metal reinforcement by thickness of concrete as follows:
 - 1. Where concrete is deposited against ground without use of forms: not less than 3 inches.
 - 2. Where concrete is exposed to weather, or exposed to ground but placed in forms: not less than 2 inches for bars more than 5/8 inch in diameter and 1-1/2 inch for bars 5/8 inch or less in diameter.
 - 3. In slabs and walls not exposed to ground: not less than 3/4 inch.
 - 4. In all cases, thickness of concrete over reinforcement shall be at least equal to diameter of bars.

- G. Position all reinforcement accurately. Secure at intersections with annealed wire ties or bar clips. Support with metal supports, spacers, or hangers of approved type.
- H. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire.

3.06 JOINTS

- A. Construction Joints:
 - 1. Locate and install construction joints so as not to impair the strength and appearance of the structure.
 - 2. Provide keyways at least 1-1/2 inches deep in all construction joints in walls, slabs, and between walls and footings.
 - 3. Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints.
- B. Isolation Joints in Slabs-On-Ground:
 - 1. Construction isolation joints in slabs-on-ground at all points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
 - 2. Joint filler and sealant materials are specified in this Section and Division 7 of this Project Manual.
- C. Contraction (Control) Joints in Slabs-on-Ground and Framed Structural Slabs: Construct contraction joints in slabs-on-ground and framed slab as required by good practice.
- D. For joint pattern for slab-on-grade, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

3.07 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto. No aluminum conduit or inserts shall be embedded in concrete.
- B. If, in the judgment of the Engineer and/or Owner's Project Manager, embedded items are located or grouped in a manner that will weaken the structure, the Design-Builder shall take necessary corrective steps.

3.08 CONCRETE PLACEMENT

- A. Pre-placement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify and cooperate with other crafts to permit installation of their work.
- B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.
- C. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
- D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

- E. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
 - 1. Observe cold weather placement of concrete as appropriate for the project location.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- F. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
 - 1. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
 - 2. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

3.09 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or by other construction. Repair and patch form tie holes and defective areas, fins and other projections exceeding 1/4" in height.
- B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. Repair and patch defective areas with fins or other projections completely removed and smoothed.
- C. Smooth Rubbed Finish: Provide smooth rubbed finish to exposed surfaces which have received smooth form finish treatment, not later than one day after form removal.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces.
- E. Repair of Surface Defects: After forms are removed, any concrete that obviously has been improperly formed, is out of alignment or level beyond required tolerances, or which shows a defective surface that cannot be satisfactorily repaired or patched, shall be removed.

3.10 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material. Slope surfaces uniformly to drains where required.
- B. Float Finish: Apply float finish to monolithic slab surface to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo. Check and level surface plane to tolerances of FF 18 - FL 15. Cut down high spots and fill low spots.
- C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating, system.

- D. Trowel and Fine Broom Finish: Apply trowel finish where ceramic or quarry tile is to be installed with thin-set mortar.
- E. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, driveways, walks, steps, and ramps.

3.11 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
 - 1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
 - 2. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- B. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.
 - 1. Provide moisture curing in accordance with ACI 301 requirements and best local practices.
 - 2. Sealer and Dustproofer: Apply a second coat of specified curing and sealing compound only to surfaces given a first coat.

3.12 REMOVAL OF FORMS

- A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 degrees F (10 degrees C) for 4 days after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28 days.

3.13 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling required to complete work.
- B. Curbs: Provide monolithic finish to interior curbs.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as required. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
- D. Grout base plates and foundations, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless directed otherwise.
- E. Reinforced Masonry: Provide 3,000 psi concrete grout for reinforced masonry cells, masonry lintels, and bond beams as required. Maintain accurate location of reinforcing steel during concrete placement. See specifications and general notes for additional requirements.

F. Concrete Stairs:

1. Screed and tamp wearing surfaces of treads, landings, and platforms to force fines to surface. Do not dust to remove excess water.
2. Add nonslip aggregate to treads, landings, and platforms when such surfaces are not covered with other materials. Apply nonslip aggregate per manufacturer's direction.
3. Provide metal nosings on all exterior stair treads. Nosings are specified under another section of these specifications. Install nosings to proper levels as treads are finished.
4. Give formed surfaces of risers, stringers, etc., a surface treatment as specified for other non-wearing concrete surfaces after forms are removed.

3.14 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas:

1. Repair and patch defective areas with cement mortar immediately after removal of forms.
2. Cut out honeycomb, rock pockets, voids over 1/2 inch in diameter, and holes left by tie-rods and bolts, down to solid concrete, but in no case to a depth of less than 1 inch.
3. For exposed-to-view surfaces, patching mortar will match color of surroundings when dry.
4. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching.

B. Repair of Formed Surfaces:

1. Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Owner's Project Manager.
2. Repair concealed formed surfaces that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete.

C. Repair of Unformed Surfaces:

1. Repair finished unformed surfaces that contain defects which adversely affect durability of concrete.
2. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete.
4. Repair defective areas except random cracks and single holes not exceeding 1 inch diameter, by cutting out and replacing with fresh concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
5. Repair isolated random cracks and single holes not over 1 inch in diameter.
6. Perform structural repairs with prior approval of Owner's Project Manager or Structural Engineer for method and procedure.

3.15 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Owner will employ a testing laboratory to perform tests and to submit test reports.

B. Sampling and testing for quality control during placement of concrete includes the following:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
2. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
3. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.

4. Concrete Temperature: Test hourly when air temperature is 40 degrees F (4 degrees C) and below, and when 80 degrees F (27 degrees C) and above; and each time a set of compression test specimens made.
 5. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each cured test specimen except when field-cure test specimens are required.
 6. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yds. plus additional sets for each 50 cu. yds. above the first 25 cu. yds. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 - a. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
 - b. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 - c. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
- C. Test results will be reported in writing to Owner's Project Manager, Structural Engineer and Design-Builder within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
- D. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Structural Engineer or Owner's Project Manager. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Design-Builder shall pay for such tests.

3.16 CLEAN-UP

- A. Immediately after completion of concrete operations, remove from site all debris resulting from work.
- B. Immediately prior to final inspection, preliminary to acceptance, wash and clean all exterior concrete wearing surfaces and interior uncovered wearing surfaces. Leave all concrete in clean, acceptable condition.

END OF SECTION